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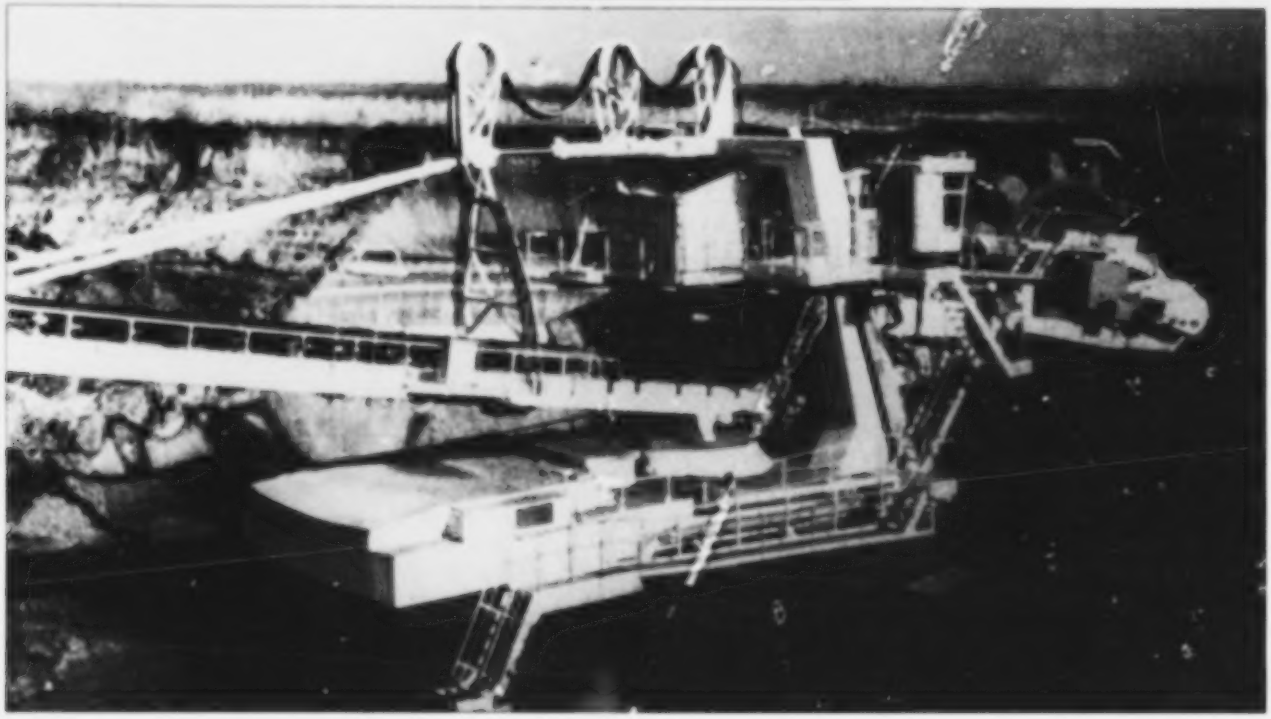

PHOSPHATE ROCK

By William F. Stowasser

1990

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

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ANNUAL REPORT

PHOSPHATE ROCK

U.S.
DEPARTMENT
OF THE
INTERIOR

Manuel Lujan, Jr.
Secretary

BUREAU
OF
MINES

T S Ary
Director

September 1991

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COVER PHOTO:
Stripping overburden with bucket wheel excavators. (Photo is courtesy of Texasgulf Chemicals Co.)

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PHOSPHATE ROCK

By William F. Stowasser

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The U.S. phosphate rock mining industry exists to primarily supply the demand for phosphate fertilizers. The fertilizer was used to promote production of food and feed grains for the domestic and international markets. The prospects for increased exports of U.S.-produced agricultural commodities was diminished when the European Community (EC) and the United States were not able to agree on modifying trading rules for agricultural products, which are not now included in the General Agreement on Tariffs and Trade. The EC resisted negotiating reductions in trade protection for agricultural products. The European Community Common Policy increased food prices inside Europe by purchasing excess farm production at artificially high prices. The overproduction was sold on world markets at competitive prices. It is probable that maintaining protectionism will reduce U.S. exports as well as those from the recognized more efficient farmers of Australia, Brazil, Canada, and New Zealand. Without the elimination of the EC's tariffs, other exporting countries will not be competitive in Europe. It is unlikely that the United States food and fertilizer export market share will increase.

World phosphate rock production declined an estimated 5% in 1990 to 154 million tons. It appears that several major producing countries produced less in 1990 compared with that of 1989. Production was controlled to meet demand and avoid unnecessary inventory in-

TABLE 1

SALIENT PHOSPHATE ROCK STATISTICS

(Thousand metric tons and thousand dollars unless otherwise specified)

	1986	1987	1988	1989	1990
United States:					
Mine production (crude ore)	135,683	148,426	162,299	170,268	151,277
Marketable production	40,320	40,954	45,389	49,817	46,343
P_2O_5 content	12,248	12,470	13,833	15,116	14,172
Value	r$897,131	r$793,280	$887,809	$1,084,022	$1,075,093
Average per metric ton[2]	$22.25	$19.37	$19.56	$21.76	$23.20
Sold or used by producers[3]	41,776	43,673	48,441	49,280	49,754
P_2O_5 content	12,750	13,286	14,760	14,935	15,098
Value	r$929,621	r$845,812	$947,721	$1,072,454	$1,154,422
Average per metric ton[2,4]	$22.25	$19.37	$19.56	$21.76	$23.20
Exports[5]	7,848	8,454	8,092	7,842	6,238
P_2O_5 content	2,521	2,737	2,608	2,522	2,019
Value[1]	$211,701	$194,691	$206,984	$227,272	$191,233
Average per metric ton[2]	$26.97	$23.03	$25.58	$28.98	$30.66
Imports for consumption	528	464	676	705	451
C.i.f. value	$25,435	$22,134	$26,310	$29,878	$21,905
Average per metric ton	r6$48.18	$47.70	$38.92	$42.44	$48.57
Consumption[7]	34,456	35,683	41,022	42,143	43,967
Stocks, Dec. 31: Producers	13,277	10,884	9,323	11,027	8,912
World: Production	141,029	r147,617	r162,041	r158,966	154,106

r Estimated.
[1] The total value is based on a weighted value.
[2] Computer-calculated average value based on the weighted sold or used values.
[3] Includes domestic sales and exports.
[4] Weighted average of sold or used values.
[5] Exports reported to the U.S. Bureau of Mines by companies.
[6] Average unit value obtained from unrounded data.
[7] Expressed as sold or used plus imports minus exports.

creases. A slackening in demand was probably caused by the political changes and uncertainties in Eastern Europe, by political changes in the U.S.S.R., and the invasion of Kuwait by Iraq.

DOMESTIC DATA COVERAGE

Domestic production data for phosphate rock are developed by the U.S. Bureau of Mines from two separate voluntary surveys of U.S. operations. Typical of these surveys is the semiannual Phosphate Rock Survey. Of the 19 operations to which a survey request was sent, all responded, representing 100% of the U.S. production data shown in table 1.

BACKGROUND

Phosphate rock deposits occur as marine phosphorites, apatite-rich igneous rock, and modern and ancient guano. All U.S. production was from marine phosphorites. It is the practice of the U.S. industry to express production and reserves in terms of beneficiated product. The grade of the product may be reported as percentage of phosphorus pentoxide (P_2O_5) or as tricalcium phosphate or expressed as percentage bone phosphate of lime (BPL). Conversion factors are $P_2O_5 = \%BPL \times 0.4576$; $\%BPL = P_2O_5 \times 2.1853$; and $P = P_2O_5 \times 0.436$. The phosphate ore bed or the zone of phosphorus-bearing material is commonly called the matrix in Florida and North Carolina.

Marketable phosphate rock was produced by 19 companies in the United States. Ten companies in Florida and one in North Carolina produced 87% of the phosphate rock. The 13% balance was produced in Idaho, Montana, Tennessee, and Utah. Approximately 95% of the phosphate rock was used to produce agricultural fertilizers and animal feed supplements. The balance was used in a variety of industrial chemicals.

Sedimentary apatite has a range of chemical compositions. The general formula for marine carbonate-apatite is $Ca_{10}(PO_4CO_3)_6Fe_{2-3}$. Apatite is host to many cation, anion, and anionic radical substitutions for PO_4. Accessory elements may be associated minerals or those that are chemical substitutions in the phosphate mineral.

The part of phosphate resources that can be profitably recovered is called reserves. Reserves may increase as new deposits are discovered and as technology is improved. Estimates of phosphate rock reserves are made for a specific date and are subject to changing economic or environmental conditions. Operating companies and companies holding phosphate lands estimate the recoverable tonnages based on current and future economics. Mining plans evolve from this planning. Estimates indicate that about 1 billion tons is recoverable from the North Carolina deposit and another billion tons is recoverable from Florida deposits.

The deposits of phosphate rock in Tennessee in the Bigby-Cannon formation are small in size and irregular in shape. They were stripped and mined with 1.5- or 2.3-cubic meter (2- or 3-cubic yard) draglines. The ore was trucked or railed to washing and classification plants before agglomerating into electric furnace feed to produce elemental phosphorus.

The phosphate rock bed of the Pungo River Formation in North Carolina is a primary marine phosphate 6 to 12 meters (20 to 40 feet) thick overlain with 27 to 40 meters (90 to 130 feet) of sand, clay, and marl overburden. The underlying aquifer was depressurized by pumping water to the surface to ensure a dry pit. Currently, bucket-wheel excavators have replaced dredges to strip the top 12 meters (40 feet) of overburden. Large capacity draglines with buckets as large as 55 cubic meters (72 cubic yards) were used to strip the remaining overburden and the matrix. The matrix was slurried with high-pressure waterjets, pumped to the beneficiation plant, washed, and classified to produce a minus 16-mesh, plus 200-mesh flotation feed. Flotation concentrate was either calcined or dried.

Most of the mines in central Florida are in the Bone Valley Formation. In North Florida, the Formation is of equivalent age. Overburden averages about 6 meters (20 feet). The overburden consists of a clay sand and a leach-zone material that overlays the matrix. The materials were selectively strip-mined with large electric draglines. The matrix was slurried in a sump and pumped to the washing plant. Cleaned screened material from the washer that was plus 14 or 16 mesh was separated and may be a salable pebble product. The minus 16-mesh fraction was deslimed, and the 16- by 150-mesh fraction was floated to produce a concentrate.

ANNUAL REVIEW

In the history of the phosphate industry in the United States, the most important development was application of the flotation process to separate sand gangue from phosphate rock minerals. The process was applied in 1927 and 1928 at International Agricultural Corp. Phosphate Recovery No. 2 plant. More than one-half of the phosphate mined was wasted before the advent of flotation. Since 1928, there has been no other equivalent technological development.

Legislation and Government Programs

The U.S. Environmental Protection Agency (EPA) was required by the Clean Air Act to review standards of performance for new, modified, or reconstructed stationary sources every 4 years. The first review of the existing new source performance standards (NSPS) for phosphate rock plants was completed to determine the need to revise existing standards. EPA concluded that no revision to the standard was necessary at this time.

The EPA on January 23, 1990, removed 5 of 20 conditionally retained mineral processing wastes from the exemption of hazardous waste regulations provided by section 3001 (b)(3)(A)(ii) of the Resource Conservation and Recovery Act (RCRA), often referred to as the Bevill exclusion. Furnace off gas solids from elemental phosphorus production was removed from the Bevill exclusion. Of the 20 mineral processing wastes that were conditionally retained within the scope of the Bevill exemption were phosphogypsum, from phosphoric acid production, and slag, from elemental phosphorus production. Process wastewater from phosphoric acid production was proposed for temporary retention in the Bevill exclusion.

The EPA will either subject the special mineral processing wastes (i.e., phosphogypsum and phosphoric acid process wastewater) to regulation under subtitle C as hazardous wastes or conclude that

such regulation is unwarranted. Wastes for which the exclusion is retained will be subject to regulation under RCRA subtitle D as solid wastes and will likely be placed into the regulatory regime being developed for mineral extraction and beneficiation wastes.

Farmers made little change in 1990 cropland use as Congress prepared new farm legislation. The 1990 farm bill targeted additional land for conservation tillage, contouring, terracing grassed waterways, and diversions to reduce cropland erosion. In addition, the long-term Conservation Reserve Program was extended as was a program to implement water quality protection and restoration of drained wetlands.

The need to cut total spending caused the most significant changes in Federal farm programs. They included the following:

1. Establishment of a new system for determining subsidy payments for farmers participating in commodity programs. The new "triple base" system requires farmers to forego subsidy payments on another 15% of their cropland, over the percent of land set aside, to obtain subsidy payments on the remainder. On the 15% reduced acres, farmers can plant any commodity crop.
2. Allowance of additional planting flexibility.
3. Establishment of a new oilseed support program.
4. Modification of the existing 0/92 program to the 0/77 program that allows farmers to plant more profitable resource-conserving crops, including oilseed but not soybeans.
5. Establishment of an integrated farm management program.
6. Broadening of purposes of agriculture research.

The conservation section of the farm bill includes programs to protect erodible land and wetlands. By 1995, 16 to 18 million hectares (40 to 45 million acres) will be enrolled in the Agricultural Resources Conservation program.

Strategic Considerations

Food security for an expanding world population from a limited land base will be difficult to accomplish in future years. Increasing world population has been one of the factors promoting world grain trade as well as demand for higher per capita food consumption levels and improved living standards. World population has increased from 3.7 billion in 1960 to an estimated 5.3 billion in 1990. The U.S. Bureau of the Census estimates that world population will increase to 6.2 billion in the year 2000 and about 10 billion in the year 2040, a short 50 years into the future.

Phosphate rock, because of its availability, was not strategically stockpiled. As world population levels increase in future years, so will the demand for phosphate rock to produce phosphate fertilizers (plant nutrients) for food production to sustain the world population. The supply of phosphate rock to increase food production in the next century will not be from the same sources as it is today. To meet the anticipated demand, phosphate rock production will rise from 154 million tons in 1990 to an estimated 300 to 400 million tons in the year 2040. This will be difficult to achieve because many of the phosphate rock mines that supply today's world demand will be depleted within a 50-year timespan. The supply of phosphate rock from deposits in the United States will probably be only one-third of its present level, even assuming that the profitability will be sufficiently high to justify mining lower quality resources. Although the United States has a substantial phosphate rock reserve base, an estimated 4.4 billion tons, Morocco's 22 billion ton base supports the probability that, without major new discoveries, it will be the principal phosphate rock supplier to the world in the next century.

Issues

A number of phosphate rock mines in Florida will close as the reserves are mined out in future years. Without the construction of new mines in Florida, the supply of phosphate rock will decline from a planned production of 40 million tons in 1993 and 1994 to 22 million tons in 1997. Deposits of phosphate rock in the southern extension of the Bone Valley Formation are known, and mining centers can be constructed if the investments can be justified. It is probable, but not assured, that when the U.S. domestic supply of phosphate rock is reduced, phosphate rock exports will diminish. Manufactured phosphate fertilizers will be available to both domestic and export markets, and, in this situation, projected to occur in the mid-1990's, the selling price of these commodities will probably increase. Return on investments will then be able to justify investment in new phosphate rock mines. If new phosphate rock mines are not developed, phosphate rock and phosphate fertilizer imports will probably increase to make up a short fall in domestic supply, concurrent with a reduction in exports. An increase in the selling price of phosphate rock and phosphate commodities, if achieved, will improve its profitability in the market; however, it is also probable that the costs associated with production will increase to meet standards set to ensure land reclamation, control hazardous wastes, minimize water consumption, and maintain air and water quality.

Production

Production of marketable phosphate rock in the United States decreased 7% in 1990 to 46.3 million tons. This was 3.5 million tons less production than was planned by producers of phosphate rock as demand for phosphate fertilizers and phosphate chemicals was less than that of 1989. The 3.5 million ton decline of production compared with that of 1989 occurred in the producing States of Florida and North Carolina. Production from Tennessee and the Western States was the same as that of 1989.

Florida and North Carolina.—Phosphate rock was produced in central Florida by Agrico Chemical Co., a division of Freeport-McMoRan Resource Partners L.P.; CF Industries Inc.; Estech Inc., owned by C&G Holdings Inc.; Gardiner Inc., 80% ownership by Cargill, Inc.; IMC Fertilizer Inc. (IMC); Mobil Mining and Minerals Co.; U.S. Agri-Chemicals Corp., owned by Sinochem (USA) Inc.; Seminole Fertilizer Corp., owned by Tosco Corp.; and Nu-Gulf Industries Inc., owned by Gulf Atlantic Corp. In northern Florida, Occidental Chemical Agricultural Products Inc. produced phosphate rock for conversion to superphosphoric acid.

Low-fluorine soft phosphate rock was recovered from hard phosphate rock tailing ponds in north-central Florida by Manko Co., Howard Phosphate Co., and Loncala Phosphate Co.

Texasgulf Inc., a subsidiary of Elf Aquitane Inc., produced phosphate rock

for domestic consumption in its adjacent fertilizer plant and for export. The mine and plant are on the Pamlico River in eastern North Carolina. The U.S. Army Corps of Engineers issued a feasibility report and environmental assessment of harbor improvement for Morehead City, NC. If implemented, it will improve the competitive export position of Texasgulf.

Tennessee.—Occidental Chemical Corp. produced elemental phosphorus in three electric furnaces from local ores in Columbia, TN.

Stauffer Chemical Co., a division of Rhône-Poulenc Basic Chemicals Inc. also produced elemental phosphorus from local ores in Mount Pleasant, TN. Monsanto Co. closed its electric furnaces in Tennessee in 1986. As a matter of interest, Albright & Wilson Americas closed its electric furnace plant at Long Harbour, Newfoundland, in 1989. Rhône-Poulenc will close the phosphate rock mines in Tennessee in early 1991 and phaseout the electric furnaces thereafter. With rising energy costs and new purified wet-process phosphoric acid technology, purified wet process plants are proliferating in the United States. Olin Corp., Joliet, IL, purifies wet-process phosphoric acid to produce sodium phosphates. A joint venture by Olin, Texasgulf, and Albright & Wilson was formed to construct a wet-process purified phosphoric acid plant at Aurora, NC. Rhône-Poulenc was constructing a new wet-process phosphoric acid purification plant at Geismar, LA.

Western States.—Phosphate rock was mined in Idaho, Montana, and Utah to produce both elemental phosphorus and phosphate fertilizers. J.R. Simplot Co. produced phosphate rock from the Gay Mine on the Fort Hall Indian Reservation and from the Smoky Canyon Mine, Caribou National Forest. Mainbed ore from the Gay Mine was used by Simplot to produce wet-process phosphoric acid, and FMC Corp. used the lower grade shale in its electric furnaces near Pocatello, ID.

Monsanto Co. supplied its electric furnaces in Soda Springs, ID, with phosphate rock from its Enoch Valley Mine in the Caribou National Forest. Rhône-Poulenc produced phosphate rock from its Wooley Valley Mine, Caribou National Forest, ID, and shipped the phosphate rock to its electric furnace plant in Silver Bow, MT. Nu-West Industries Inc., a member of the Conda Partnership with Western Coop Fertilizer Co., produced phosphate rock from the Maybie Canyon, Mountain Fuel, and Champ Williams Mines in the Caribou National Forest. The phosphate rock was shipped by rail to Conda, ID, beneficiated, calcined, and used to produce wet-process phosphoric acid. Cominco American Inc. operated the only underground phosphate rock mine in the United States. The mine, beneficiation plant, and drying operation are near Garrison, MT. The product was exported to Canada. Chevron Resources Co. produced and concentrated phosphate rock from its mine near Vernal, UT. The slurry concentrate was pumped to Rock Springs, WY.

Consumption and Uses

In recent years, the demand pattern for phosphate rock has shown a gradual decline in phosphate rock exports, and about one-half of that consumed domestically was exported in a higher value form. More than 77% of the phosphate rock was used to produce wet-process phosphoric acid for the domestic and export markets, and the balance was used to produce a series of chemicals from elemental phosphorus.

Elemental phosphorus from electric furnace operations may be converted into cobalt phosphate for pigments and animal feed supplements; into copper phosphide for phosphor bronze; into red elemental phosphorus for safety matches and pyrotechnics; into phosphorus trichloride for phosphorus oxy-

TABLE 2

PRODUCTION OF PHOSPHATE ROCK IN THE UNITED STATES, BY REGION

(Thousand metric tons and thousand dollars)

Region	Mine production		Marketable production							Ending stocks
			Used directly		Beneficiated		Totals			
	Rock	P_2O_5 content	Rock	P_2O_5 content	Rock	P_2O_5 content	Rock	P_2O_5 content	Value[1]	
1989:[2]	170,268	27,490	3,899	1,058	45,919	14,058	49,817	15,116	1,084,022	11,027
1990:										
January-June										
Florida and North Carolina	71,789	8,135	r337	100	19,766	6,046	r20,103	6,146	r467,372	8,072
Idaho, Montana, Tennessee, and Utah	4,164	1,013	1,249	326	1,448	447	r2,697	773	r60,840	1,589
Total	75,953	9,148	r1,586	426	21,214	6,493	22,800	6,919	r528,212	9,661
July-December										
Florida and North Carolina	71,187	7,765	249	78	20,009	6,202	20,258	6,280	483,356	7,440
Idaho, Montana, Tennessee, and Utah	4,137	1,012	1,818	500	1,467	473	3,285	973	63,525	1,472
Total	75,324	8,777	2,067	578	21,476	6,675	23,543	7,253	546,881	8,912
Grand total	151,277	17,925	3,653	1,004	42,690	13,168	46,343	14,172	1,075,093	XX

r Revised. XX Not applicable.
[1] Computer-calculated value based on the weighted sold or used value.
[2] Data may not add to totals shown because of independent rounding.

chloride, phosphorus pentachloride gasoline additives, plasticizers, and dyestuffs; into phosphorus trisulfide for matches; and into phosphorus pentasulfide for lubricating oil additives, flotation reagents, rubber additives, and a stabilizer for aromatic amines. Phosphorus pentoxide was used to produce phosphoric acid for a large number of products—phosphorus oxychloride catalyst for air blown asphalt, for drying agents, for leather tanning, medicine, liquid paint remover formulations, dehydrating agents, and sugar refining. There are military applications for elemental phosphorus to produce smoke columns and screens and incendiary bombs and shells. The byproduct of elemental phosphorus, ferrophosphorus, was used in alloy steels and processed to recover contained vanadium.

Wet-process phosphoric acid was used to produce the fertilizers ammonium phosphates, triplesuperphosphate, monobasic and dibasic calcium phosphates for animal feed supplements, and detergents of sodium and potassium polyphosphates. Mineral feed supplement rock was produced from defluorinated phosphate rock. Byproducts from wet-process phosphoric acid include phosphogypsum, uranium, vanadium, calcium chloride, sodium fluorosilicate, and fluosilicic acid.

Phosphate rock exports as well as imports declined in 1990. Exports of phosphate fertilizers held at a high level in 1990, possibly explaining the fact that phosphate rock exports declined to 6.2 million tons in 1990, about 20% less than that of 1989. Most of the phosphate rock imports was used by producers of liquid fertilizer.

Stocks

About 90% of phosphate rock stocks in the United States was held adjacent to the beneficiation plants in Florida and North Carolina. Inventoried phosphate rock in Florida and North Carolina was either dried for export, calcined to increase grade and potential phosphoric acid quality, or wet ground to produce phosphoric acid. In the Western States, phosphate rock was stockpiled during the warm months of the year near electric furnaces and wet-process phosphoric acid plants to avoid the problem of unloading frozen ore from railroad cars and truck boxes in the wintertime.

The level of phosphate rock inventories declined from a peak of 20 million tons in 1981 to 9.3 million tons in 1988. Yearend stocks in 1989 and 1990 were about 11 million tons and 9 million tons, respectively, indicating producers were controlling phosphate rock inventories.

Transportation

From production centers in central and north Florida, phosphate rock and phosphate fertilizers were moved by rail to terminals on Hillsborough Bay, FL, and in Jacksonville, FL. In central Florida, CSX Transportation railroad moved product to terminals on Tampa/Hillsborough Bay. The Rockport terminal was owned and operated by the CSX railroad, Port Sutton was owned and

TABLE 3

U.S. PHOSPHATE ROCK SOLD OR USED GRADE DISTRIBUTION PATTERN

Grade (percent BPL[1] content)	Distribution (percentage)				
	1986	1987	1988	1989[2]	1990
74 or more	4.5	3.4	2.0	0.8	0.3
72 to less than 74	4.0	5.4	5.6	7.4	8.3
70 to less than 72	7.8	7.1	8.8	6.2	3.9
66 to less than 70	57.5	61.6	59.7	61.7	59.5
60 to less than 66	20.3	17.5	14.9	19.3	19.8
Less than 60	5.9	5.0	9.0	4.7	8.2

[1] 1.0% BPL (bone phosphate of lime or tricalcium phosphate) = 0.458% P_2O_5.
[2] Data do not add to 100% because of independent rounding.

TABLE 4

FLORIDA AND NORTH CAROLINA PHOSPHATE ROCK SOLD OR USED GRADE DISTRIBUTION PATTERN

Grade (percent BPL[1] content)	Distribution (percentage)				
	1986	1987	1988	1989	1990
74 or more	5.1	3.8	2.3	0.9	0.3
72 to less than 74	4.6	6.0	6.4	7.6	7.6
70 to less than 72	9.0	7.6	8.2	6.2	4.4
66 to less than 70	60.7	65.3	64.0	66.4	63.4
60 to less than 66	20.6	17.3	14.4	18.9	19.3
Less than 60	—	([2])	4.7	—	5.0

[1] 1.0% BPL (bone phosphate of lime or tricalcium phosphate) = 0.458% P_2O_5.
[2] Less than 0.1 of 1%.

TABLE 5

TENNESSEE AND WESTERN STATES PHOSPHATE ROCK SOLD OR USED GRADE DISTRIBUTION PATTERN

Grade (percent BPL[1] content)	Distribution (percentage)				
	1986	1987	1988	1989	1990
72 to less than 74	—	—	—	5.6	13.4
70 to less than 72	—	3.5	12.5	6.1	—
66 to less than 70	36.1	33.9	29.8	28.6	30.7
60 to less than 66	18.5	19.3	18.2	21.8	23.5
Less than 60	45.4	43.3	39.5	37.9	32.4

[1] 1.0% BPL (bone phosphate of lime or tricalcium phosphate) = 0.458% P_2O_5.

TABLE 6

PHOSPHATE ROCK SOLD OR USED BY PRODUCERS IN THE UNITED STATES, BY GRADE AND REGION

(Thousand metric tons and thousand dollars)

Grade (percent BPL[1] content)	Florida and North Carolina			Tennessee and Western States[2]			Total		
	Rock	P_2O_5 content	Value[3]	Rock	P_2O_5 content	Value[3]	Rock	P_2O_5 content	Value[3]
January–June 1989	22,074	6,763	479,960	2,718	784	60,809	24,792	7,547	540,769
July–December 1989	21,056	6,422	472,034	3,431	968	59,650	24,487	7,390	531,684
January–June 1990:									
74 or more	21	8	681	—	—	—	21	8	681
72 to less than 74	1,620	541	49,430	379	127	13,372	1,999	668	62,802
70 to less than 72	1,135	369	34,478	—	—	—	1,135	369	34,478
66 to less than 70	14,850	4,543	313,001	782	243	20,549	15,632	4,786	333,550
60 to less than 66	4,425	1,251	115,086	688	193	12,253	5,113	1,444	127,339
Below 60	—	—	—	r764	192	12,758	r764	192	12,758
Total	22,051	6,712	512,676	r2,613	755	58,932	r24,664	7,467	571,608
July–December 1990:									
74 or more	104	36	4,238	—	—	—	104	36	4,238
72 to less than 74	1,702	568	52,805	408	135	14,840	2,110	703	67,645
70 to less than 72	823	266	25,342	—	—	—	823	266	25,342
66 to less than 70	12,962	3,967	295,548	1,020	320	24,857	13,982	4,287	320,405
60 to less than 66	4,048	1,264	76,839	692	197	9,760	4,740	1,461	86,599
Below 60	2,186	590	65,982	1,145	288	12,603	3,331	878	78,585
Total	21,825	6,691	520,754	3,265	940	62,060	25,090	7,631	582,814

r Revised.
[1] 1.0% BPL (bone phosphate of lime or tricalcium phosphate) = 0.458% P_2O_5.
[2] Includes Idaho, Montana, and Utah.
[3] F.o.b. mine.

TABLE 7

PHOSPHATE ROCK SOLD OR USED BY PRODUCERS IN THE UNITED STATES, BY USE

(Thousand metric tons)

Use	1989 total		1990					
			January–June		July–December		Total	
	Rock	P_2O_5 content	Rock	P_2O_5 content	Rock	P_2O_5 content	Rock	P_2O_5 content
Domestic:[1]								
Wet-process phosphoric acid	37,931	11,394	19,762	5,939	18,647	6,175	38,409	12,114
Normal superphosphate	937	297	308	94	2,075	101	2,383	195
Triple superphosphate	410	137	206	68	223	73	429	141
Defluorinated rock	—	—	—	—	—	—	—	—
Direct applications	3	1	2	1	1	—	3	1
Elemental phosphorus	2,122	575	1,015	278	1,241	341	2,256	619
Ferrophosphorus	37	9	r19	r4	17	5	36	9
Total[2]	41,437	12,413	r21,312	r6,384	22,204	6,695	43,516	13,079
Exports[3]	7,842	2,522	3,352	1,083	2,886	936	6,238	2,019
Grand total[2]	49,280	14,935	r24,664	r7,467	25,090	7,631	49,754	15,098

r Revised.
[1] Includes rock converted to products and exported.
[2] Data may not add to totals shown because of independent rounding.
[3] Exports reported to the U.S. Bureau of Mines by companies.

TABLE 8

PHOSPHATE ROCK SOLD OR USED BY PRODUCERS IN THE UNITED STATES, BY USE AND REGION

(Thousand metric tons)

Use	Florida and North Carolina		Tennessee and Western States[1]		Total	
	Rock	P_2O_5 content	Rock	P_2O_5 content	Rock	P_2O_5 content
1989:[2]	43,130	13,185	6,151	1,752	49,279	14,935
1990:						
January-June:						
Domestic:[3]						
Agricultural	18,716	5,635	1,561	466	20,278	r6,101
Industrial	46	13	989	270	r1,034	283
Subtotal	18,762	5,648	2,550	736	r21,312	r6,384
Exports[4]	3,289	1,064	63	19	3,352	1,083
Total	22,051	6,712	2,613	755	r24,664	r7,467
July-December:						
Domestic:[3]						
Agricultural	18,969	5,764	1,976	586	20,946	6,350
Industrial	27	8	1,231	337	1,258	345
Subtotal	18,996	5,772	3,207	923	22,204	6,695
Exports[4]	2,829	919	57	17	2,886	936
Total	21,825	6,691	3,265	940	25,090	7,631
Grand total	43,876	13,403	5,878	1,695	49,754	15,098

r Revised.
[1] Includes Idaho, Montana, and Utah.
[2] Data may not add to totals shown because of independent rounding.
[3] Includes rock converted to products and exported.
[4] Exports reported to the U.S. Bureau of Mines by companies.

TABLE 9

FLORIDA AND NORTH CAROLINA PHOSPHATE ROCK SOLD OR USED BY PRODUCERS

Year	Rock (thousand metric tons)	P_2O_5 content (thousand metric tons)	Value	
			Total[1] (thousands)	Average per ton f.o.b. mine
1986	36,333	11,236	$810,429	$22.31
1987	38,692	11,891	765,061	19.77
1988	42,395	13,036	829,963	19.58
1989	r43,130	r13,185	951,995	22.07
1990	43,876	13,403	1,033,430	23.55

r Revised.
[1] The total value is based on a weighted value.

operated by IMC, Eastern Associated Terminal (E.A.T.) was owned and operated by E.A.T, and Big Bend was owned and operated by Agrico Mining Co.

Markets and Prices

The price or value of phosphate rock was obtained by semiannually surveying the producing companies to obtain domestic and export selling prices for each grade of phosphate rock, f.o.b. mine. The data were used to calculate the average selling price for each grade of phosphate rock in the domestic and export market. Historical average selling prices from 1970 through 1990 are shown in table 12.

Estimates of phosphate rock export prices, unground, f.o.b. vessel, Tampa Range or Jacksonville, FL, by grade are shown in table 13. The estimates indicate that export prices increased about $3.00 per ton from Florida. Table 14 shows estimates of Moroccan phosphate rock export prices, U.S. dollars per ton, f.a.s. Laayoune, Casablanca, or Jorf Lasfar. Tables 15, 16, and 17 show the price or value of Florida and North Carolina, Tennessee and the Western States, and the United States, respectively, by grade for the domestic and export markets and an average selling price.

In north Florida, the Norfolk Southern Railroad moved phosphate rock from Occidental's mines to Occidental's terminal in Jacksonville, FL.

Rail freight published tariffs and loading charges for phosphate rock at central Florida terminals were $6.46 per ton. The published freight and loading cost in North Florida was $9.08 per ton.

The U.S. Corps of Engineers completed deepening the Tampa Bay Channel, Hillsborough Bay Channel, and Sparkman Channel to a depth of 13.7 meters (45 feet) to accommodate deep draft vessels. Berth 31, adjacent to the Port Sutton turning basin, was deepened to 13.1 meters (43 feet). The berth accommodates larger vessels carrying more cargo to use the port. The berth was used to "top-off" phosphate rock cargoes.

In Tennessee and the Western States, phosphate rock was moved by both railroad and truck to either beneficiation plant or electric furnace facilities. Phosphate concentrates were transported by pipeline by two companies producing in Idaho and Utah.

TABLE 10

TENNESSEE AND WESTERN STATES[1] PHOSPHATE ROCK SOLD OR USED BY PRODUCERS

Year	Rock (thousand metric tons)	P_2O_5 content (thousand metric tons)	Value	
			Total[2] (thousands)	Average per ton f.o.b. mine
1986	5,443	1,515	$119,192	$21.90
1987	4,981	1,395	80,751	16.21
1988	6,047	1,723	117,758	19.47
1989	6,151	r1,752	120,459	19.58
1990	5,878	1,695	120,992	20.58

r Revised.
[1] Includes Idaho, Montana, and Utah.
[2] The total value is based on a weighted value.

Self-unloading barges were used in North Carolina to transport phosphate rock concentrates from the Aurora Mine to the Morehead City Port Terminal.

Foreign Trade

Large fertilizer plants, near the supply of phosphate rock and sulfur, generally have lower capital and operating costs compared with smaller plants and, by minimizing transportation costs, their competitive position is improved. Trade in high-analysis phosphate fertilizers has increased, and trade in low-analysis phosphate rock has declined as was exemplified by the reduction in world phosphate rock exports in the 1980's.

The United States was a net exporter of phosphate rock in 1990. Phosphate rock exports declined by about 20% compared with that of 1989. Exports of higher value phosphate fertilizers were similar to those of 1989. The export tons and values for ground and unground phosphate rock, superphosphates, ammonium phosphates, phosphoric acid, and elemental phosphorus are shown in tables 18 through 25.

The principal countries that have sources of phosphate that compete in international trade are Algeria, Israel, Jordan, Morocco, Senegal, Syria, the Republic of South Africa, Togo, Tunisia, and the United States. Countries with indigenous supplies of phosphate rock have recognized the advantages of exporting high-analysis phosphate fertilizers rather than phosphate rock. U.S. phosphate rock exports have declined, and exports of ammonium phosphates and superphosphates have increased during the past decade.

Phosphate rock was exported from

TABLE 11

MARKETABLE PHOSPHATE ROCK YEAREND STOCKS

(Million metric tons)

Year	Quantity
1981	19.6
1982	18.3
1983	14.5
1984	11.9
1985	15.5
1986	13.3
1987	10.9
1988	9.3
1989	11.0
1990	8.9

TABLE 12

TIME-PRICE RELATIONSHIPS FOR PHOSPHATE ROCK[1]

(Dollars per metric ton)

Year	Actual prices	Based on constant 1990 dollars
1970	5.80	18.16
1971	5.80	17.18
1972	5.62	15.89
1973	6.24	16.58
1974	12.10	29.47
1975	25.35	56.21
1976	21.26	44.31
1977	17.39	33.98
1978	18.56	33.80
1979	20.04	33.53
1980	22.78	34.95
1981	26.63	37.25
1982	25.52	33.56
1983	23.97	30.34
1984	23.99	29.29
1985	24.31	28.83
1986	22.25	25.71
1987	19.37	21.70
1988	19.56	21.20
1989	21.76	22.66
1990	23.20	23.20

[1] Average annual U.S. producer domestic and export price, f.o.b. mine.

TABLE 13

PHOSPHATE ROCK ESTIMATED EXPORT PRICES[1] PER METRIC TON, UNGROUND, F.O.B. VESSEL TAMPA RANGE OR JACKSONVILLE, FL, BY GRADE

Grade (percent BPL[2] content)	1987[3]	1988[4]	1989[5]	1990[6]
75	$32.00	$33.00	$38.00	$41.50
72	29.00	31.00	35.50	38.50
70	27.50	28.00	32.00	36.00
68	24.00	26.00	31.00	34.00

[1] Prices include severance taxes, rail freight costs from mine to port, and port loading and weighing charges.
[2] 1.0% BPL (bone phosphate of lime or tricalcium phosphate) = 0.458% P_2O_5.
[3] Estimated selling price, including a revised severance tax of $2.49.
[4] Estimated selling price, including a revised severance tax of $1.99.
[5] Estimated selling price, including a revised severance tax of $1.48.
[6] Estimated selling price, including $1.52 severance tax.

Note.—Estimated 1991 severance tax is $1.62.
Source: Florida State tax office.

central Florida mines through Tampa, FL; Occidental in North Florida exported through Jacksonville, FL; Texasgulf exported through Morehead City, NC; and Western States phosphate rock was exported into Canada.

Phosphate rock imports declined from 705,000 tons in 1989 to about 451,000 tons in 1990. In past years, phosphoric acid plants at Taft, LA, and Pascagoula, MS, imported Moroccan phosphate rock. Currently, a Geismar, LA, phosphoric acid plant is importing phosphate rock from the Moroccan Bou Craa phosphate rock mine to produce super phosphoric acid for liquid fertilizer. Weak fertilizer demand from the U.S. market has reduced the demand for imported phosphate rock.

World Review

The changes in the political systems in Eastern Europe and the war in the Middle East reduced the demand for phosphate fertilizers in these parts of the world and reduced phosphate rock exports from involved Middle East countries. Restricting Iraqi trade eliminated exports of sulfur, phosphate rock, and phosphate fertilizers and reduced exports of phosphate rock and phosphate fertilizers from Jordan. The Persian Gulf crisis has decreased the stability of several economies in the region that supply raw materials and finished fertilizers.

There were no significant changes in the function of the world phosphate rock industry with the exception of the impact of the Gulf war on Jordan. The Port of Aqaba operated at 80% of its capacity. Another contributing factor to the decline of phosphate rock shipments from Syria and Jordan was the drop in demand from Eastern European Countries.

The world phosphate rock capacity was estimated and is shown in table 27. An estimated capacity of about 200 million tons was unchanged from the 1989 estimate. In countries where mines have closed for reasons of depletion of reserves or high costs, world production was maintained by increasing the output from existing mines or by moving mining equipment to another deposit. The mining capacity was essentially maintained.

The U.S. Bureau of Mines has estimated world phosphate rock reserves and the reserve base. Reserves and re-

TABLE 14

MOROCCAN PHOSPHATE ROCK EXPORT PRICES, U.S. DOLLARS PER METRIC TON, F.A.S. CASABLANCA, JORF LASFAR, AND LAAYOUNE, BY GRADE[1]

Grade (percent BPL[2] content)	1985	1986	1987	1988	1989	1990[e]
Khouribga:						
72 to 73	40.50	40.50	35.00	40.50	45.00	48.00
70 to 71	39.50	39.00	34.00	38.50	42.00	45.00
Youssoufia:						
74 to 75	—	40.50	39.50	45.00	49.00	51.00
68 to 69	—	30.50	30.00	34.00	37.00	40.00
Phosboucraa:						
79 to 80	43.00	42.00	40.50	45.50	50.50	53.00

[e] Estimated.
[r] Revised.
[2] 1.0% BPL (bone phosphate of lime or tricalcium phosphate) = 0.458% P_2O_5.

Source: Moroccan Office Cherifien des Phosphates.

TABLE 15

PRICE OR VALUE OF FLORIDA AND NORTH CAROLINA PHOSPHATE ROCK, BY GRADE

(Dollars per metric ton, f.o.b. mine)

Grade (percent BPL[1] content)	1989			1990		
	Domestic	Export	Average	Domestic	Export	Average
74 or more	27.70	38.63	29.87	31.84	40.77	39.25
72 to less than 74	25.73	30.57	29.29	27.83	32.17	30.78
70 to less than 72	25.04	29.47	28.90	26.12	30.95	30.56
66 to less than 70	19.68	26.73	20.31	21.39	29.25	21.88
60 to less than 66	22.83	20.82	22.76	22.91	13.19	22.65
Less than 60	—	—	—	30.18	—	30.18
Average	20.65	28.67	22.07	22.44	30.43	23.55

[1] 1.0% BPL (bone phosphate of lime or tricalcium phosphate) = 0.458% P_2O_5.

TABLE 16

PRICE OR VALUE OF TENNESSEE AND WESTERN STATES[1] PHOSPHATE ROCK, BY GRADE

(Dollars per metric ton, f.o.b. mine)

Grade (percent BPL[2] content)	1989			1990		
	Domestic	Export	Average	Domestic	Export	Average
72 to less than 74	36.93	—	36.93	35.85	—	35.85
70 to less than 72	36.38	—	36.38	—	—	—
66 to less than 70	26.50	44.88	27.56	24.62	42.47	25.19
60 to less than 66	10.02	40.00	11.61	7.31	41.67	15.95
Less than 60	12.87	—	12.87	13.29	—	13.29
Average	18.91	42.87	19.58	18.44	42.05	20.58

[1] Includes Idaho, Montana, and Utah.
[2] 1.0% BPL (bone phosphate of lime or tricalcium phosphate) = 0.458% P_2O_5.

TABLE 17

PRICE OR VALUE OF U.S PHOSPHATE ROCK, BY GRADE

(Dollars per metric ton, f.o.b. mine)

Grade (percent BPL[1] content)	1989			1990		
	Domestic	Export	Average	Domestic	Export	Average
74 or more	27.70	38.63	29.87	31.84	40.77	39.25
72 to less than 74	28.93	30.57	30.02	31.23	32.17	31.75
70 to less than 72	30.99	29.47	29.83	26.12	30.95	30.56
66 to less than 70	20.08	27.42	20.73	21.59	29.67	22.08
60 to less than 66	21.05	24.61	21.19	20.76	19.42	21.71
Less than 60	12.87	—	12.87	22.31	—	22.31
Average	20.40	28.98	21.76	21.91	30.66	23.20

[1] 1.0% BPL (bone phosphate of lime or tricalcium phosphate) = 0.458% P_2O_5.

TABLE 18

U.S. EXPORTS OF GROUND PHOSPHATE ROCK, BY COUNTRY

(Thousand metric tons and thousand dollars)

(HTS No. 2510.20.0000)

Country	1989		1990	
	Quantity	Value	Quantity	Value
Australia	5		5	
Canada	165		126	
France	586		473	
Germany, Federal Republic of	211		47	
India	10		25	
Italy	17		—	
Japan	1	NA	—	NA
Korea, Republic of	1		1	
Mexico	46		65	
Netherlands	361		144	
New Zealand	163		130	
Romania	39		42	
Other	40		26	
Total	1,645	57,708	1,084	38,695

NA Not available.

Source: Bureau of the Census.

serve base estimates shown in tables 28 and 29 include those with costs less than $40 and $100 per ton, respectively. The reserve and reserve base estimates are largest in the continent of Africa and include the carbonatite deposit in the Republic of South Africa and the vast sedimentary deposits in northwest Africa. Significant reserves exist in the U.S.S.R and in Florida and North Carolina in the United States.

OUTLOOK

During the next 3 to 5 years, the supply of phosphate rock is forecast to be adequate to meet agriculture and industrial demands. World demand is forecast to increase at an annual rate of 1% to 2% to meet the demands of population increases.

Although the Bevill amendment excluded solid waste from regulatory control under the Resource Conservation and Recovery Act, the EPA, in 1989 and 1990, defined which processing wastes met high-volume, low-hazard criteria. The wastes that did not meet both criteria would be subject to subtitle C regulation. The final mineral processing report to Congress was made in July 1990, and the final mineral processing regulatory determination will be made in 1991.

Phosphate rock exports show a declining trend. Conversion of phosphate rock into higher analysis and value products has increased in the United States and the world to maximize the profitability of the commodity. Imports of high-grade and high-quality phosphate rock to manufacture phosphoric acid and liquid phosphoric fertilizers increased in the late 1980's, but, at this time, a growth trend does not appear to be developing.

It is probable that additional facilities will be constructed in the United States to purify wet-process phosphate acid to compete with products manufactured from the electric furnace, elemental phosphorus, and phosphoric acid route. Increasing power costs will encourage reduction in the number of electric furnaces and promote wet-process acid purification.

In recent years, about one-half of the phosphate rock mined was exported as phosphate rock, phosphate fertilizers, and phosphate chemicals. The importance of the export market to the U.S. phosphate industry cannot be overestimated. The ability of the U.S. phosphate rock industry to supply future domestic and export markets is of some concern when it is recognized that phosphate rock reserves are finite.

The survey of world phosphate rock producers performed by the International Fertilizer Industry Association (IFA) shows that world phosphate rock production has declined from 164 million tons in 1988 to 162 million tons in 1989 and, based on production reports from principal world producers, may decline in 1990 to about 154 million tons. The statistics showing declining production occurred during a period of increasing world demand. All of the world forecasting organizations, including IFA, the World Bank, and the Wharton Econometric Forecasting Association, predict a demand increase of

1% to 2% per year for phosphates.

The reasons for declining production during a period of increasing demand are not clear. It may be explained if it is assumed that production data were different from that reported or the annual supply of phosphate rock was much greater than demand, without drawing down inventories, to accommodate the increase in demand. Phosphate consumption in the recently liberated centrally planned economy countries in Eastern Europe may have been lower than expected, or production estimates from centrally planned economy countries may be overestimated.

U.S. phosphate rock production was 45.4 million tons in 1988, 49.8 million tons in 1989, and 46.3 million tons in 1990. Phosphate consumption by major importing countries such as China and India will maintain U.S. diammonium phosphate exports at their current level, and the demand created by U.S. farm programs will complicate the outlook for 1991. Domestic fertilizer use is projected to decline in 1991, exports of phosphate rock are projected to decline in 1991, and exports of phosphate rock are projected to improve.

OTHER SOURCES OF INFORMATION

Fertilizer International.

International Fertilizer Industry Association Ltd.

The British Sulphur Corp. Ltd., Phosphorus and Potassium.

The Fertilizer Institute, Dealer Progress.

The Moroccan Office Cherifien des Phosphates.

The Phosphate Rock Export Association.

TABLE 19

U.S. EXPORTS OF UNGROUND PHOSPHATE ROCK, BY COUNTRY

(Thousand metric tons and thousand dollars)

(HTS No. 2510.10.0000)

Country	1989		1990	
	Quantity	Value	Quantity	Value
Australia	282		64	
Austria	32		104	
Belgium-Luxembourg	294		412	
Brazil	—		57	
Canada	766		341	
Finland	37		21	
France	92		147	
Germany, Federal Republic of	353		291	
India	420		378	
Italy	88		102	
Japan	790	NA	688	NA
Korea, Republic of	1,267		1,275	
Mexico	610		798	
Netherlands	662		763	
New Zealand	42		46	
Philippines	—		—	
Poland	631		29	
Romania	—		42	
Sweden	196		209	
Other	117		108	
Total	[1]6,678	231,282	5,875	215,409

NA Not available.

[1]Data do not add to total because of independent rounding.

Source: Bureau of the Census.

TABLE 20

U.S. EXPORTS OF SUPERPHOSPHATES, MORE THAN 40% P_2O_5, BY COUNTRY

(Thousand metric tons and thousand dollars)

(HTS No. 3103.10.0020)

Country	1989		1990	
	Quantity	Value[1]	Quantity	Value[1]
Argentina	8		9	
Australia	56		155	
Bangladesh	102		50	
Brazil	2		41	
Canada	—		14	
Chile	110		131	
Colombia	8		8	
Costa Rica	11	NA	9	NA
Czechoslovakia	—		6	
Dominican Republic	2		2	
Germany, Federal Republic of	67		51	
Japan	48		48	
Peru	21		—	
Uruguay	6		13	
Other	76		177	
Total	517	149,377	714	95,786

NA Not available.
[1] All values f.a.s.

Source: Bureau of the Census.

TABLE 21

U.S. EXPORTS OF SUPERPHOSPHATES, LESS THAN 40% P_2O_5, BY COUNTRY

(HTS No. 3103.10.0010)

Country	1989		1990	
	(Quantity metric tons)	Value[1] (thousands)	Quantity (metric tons)	Value[1] (thousands)
Argentina	—		3,390	
Canada	3,312		17,322	
Ecuador	2,983		5,498	
Spain	6,026	NA	2,598	NA
Uruguay	4,012		—	
Other	776		3,864	
Total	17,109	$2,484	32,672	$4,844

NA Not available.
[1] All values f.a.s.

Source: Bureau of the Census.

TABLE 22

U.S. EXPORTS OF DIAMMONIUM PHOSPHATES, BY COUNTRY

(Thousand metric tons and thousand dollars)

(HTS No. 3105.30.0000)

Country	1989		1990	
	Quantity	Value[1]	Quantity	Value[1]
Argentina	80		74	
Australia	246		318	
Belgium-Luxembourg	463		361	
Brazil	12		32	
Canada	614		185	
Chile	78		63	
China	2,337		2,778	
Colombia	104		131	
Costa Rica	19		23	
Dominican Republic	43		34	
Ecuador	26		16	
France	54		25	
Germany, Federal Republic of	34		89	
Guatemala	6		2	
India	2,255	NA	1,345	NA
Iran	128		248	
Ireland	45		19	
Italy	116		20	
Japan	367		457	
Kenya	74		81	
Mexico	51		25	
New Zealand	30		48	
Pakistan	33		544	
Peru	30		11	
Spain	90		91	
Thailand	88		38	
Turkey	268		401	
Uruguay	31		—	
Venezuela	100		47	
Yugoslavia	52		10	
Other	419		240	
Total	8,293	1,465,749	7,756	1,278,559

NA Not available.
[1] All values f.a.s.

Source: Bureau of the Census.

TABLE 23

U.S. EXPORTS OF MONOAMMONIUM PHOSPHATES, BY COUNTRY

(Thousand metric tons and thousand dollars)

(HTS No. 3105.40.0000)

Country	1989		1990	
	Quantity	Value[1]	Quantity	Value[1]
Argentina	6		8	
Australia	88		130	
Belgium-Luxembourg	10		—	
Brazil	3		53	
Canada	240		248	
Chile	5		15	
China	56		—	
Colombia	35		49	
Costa Rica	—		(2)	
Dominican Republic	—		(2)	
Ecuador	3		1	
Guatemala	12		29	
Hungary	29	NA	—	NA
Ireland	—		5	
Italy	61		20	
Japan	121		93	
Mexico	1		5	
New Zealand	5		9	
Peru	—		(2)	
Saudi Arabia	62		26	
Spain	—		3	
Thailand	27		9	
Uruguay	2		—	
Venezuela	31		21	
Other	12		13	
Total	809	142,515	737	135,660

NA Not available.
[1] All values f.a.s.
[2] Less than 1/2 unit.

Source: Bureau of the Census.

TABLE 24

U.S. EXPORTS OF PHOSPHORIC ACID, LESS THAN 65% P_2O_5, BY COUNTRY

(Thousand metric tons and thousand dollars)

(HTS No. 2809.20.0010)

Country	1989		1990	
	Quantity	Value[1]	Quantity	Value[1]
Australia	49		43	
Canada	12		3	
Colombia	34		5	
India	455	NA	330	NA
Indonesia	—		69	
Japan	19		—	
Venezuela	110		58	
Other	24		47	
Total	703	124,074	555	95,881

NA Not available.
[1] All values f.a.s.

Source: Bureau of the Census.

TABLE 25

U.S. EXPORTS OF ELEMENTAL PHOSPHORUS, BY COUNTRY

(HTS No. 2804.70.0000)

Country	1989		1990	
	Quantity (metric tons)	Value[1] (thousands)	Quantity (metric tons)	Value[1] (thousands)
Brazil	434	$933	450	$985
Canada	38	60	1,470	1,850
Japan	9,758	15,118	9,802	17,269
Korea, Republic of	1,746	2,863	400	636
Mexico	7,280	8,856	5,441	8,300
Taiwan	9	21	16	21
Other	669	443	337	559
Total	19,934	28,294	17,916	29,620

[1] All values f.a.s.

Source: Bureau of the Census.

TABLE 26

U.S. IMPORTS FOR CONSUMPTION OF PHOSPHATE ROCK AND PHOSPHATIC MATERIALS

(Thousand metric tons and thousand dollars)

Phosphatic materials	HTS No.[1]	1989		1990	
		Quantity	Value[2]	Quantity	Value[2]
Natural calcium[3] phosphates unground	2510.10.0000	705	29,878	451	21,905
Natural calcium[3] phosphates ground	2510.20.0000	(4)	254	(4)	163
Dicalcium phosphate	2835.25.0000	76	43,184	2	2,744
Phosphorus	2804.70.0000	—	—	10	17,532
Normal superphosphate	3103.10.0010	1	286	1	361
Triple superphosphate	3103.10.0020	(4)	22	(4)	14
Diammonium phosphate	3105.30.0000	14	3,903	11	3,271
Fertilizer containing nitrates and phosphates	3105.51.0000	18	2,736	2	322
Phosphoric acid	2809.20.0010	(4)	21	(4)	53

[1] Harmonized tariff schedule of the United States.
[2] Declared c.i.f values.
[3] Excludes reported imports from Canada and Israel.
[4] Less than 1/2 unit.

Source: Bureau of the Census.

TABLE 27

WORLD PHOSPHATE ROCK ANNUAL PRODUCTION CAPACITY, DECEMBER 31, 1990, RATED CAPACITY[1]

(Million metric tons per year)

Country	Capacity
North America:	
Mexico	1.0
United States	55.0
Total	56.0
South America	10.0
Europe:	
U.S.S.R.	36.0
Other	1.0
Total	37.0
Africa:	
Algeria	2.3
Morocco/Sahara	32.0
Senegal	2.1
South Africa, Republic of	4.7
Togo	3.2
Tunisia	10.0
Other	1.2
Total	55.5
Asia:	
China	19.0
Israel	4.0
Jordan	8.0
North Korea	1.0
Vietnam	1.0
Other	1.0
Total	34.0
Oceania:	
Australia	1.0
Nauru	2.0
Total	3.0
World total	195.5

[1] Includes capacities of operating plants as well as plants on standby basis.

TABLE 28

U.S. PHOSPHATE ROCK RESERVE AND RESERVE BASE ESTIMATES

(Million metric tons)

State	Reserves[1]	Reserve base[2]
Florida	750	2,540
Idaho	90	160
Montana	1	1
North Carolina	390	790
Tennessee	6	10
Utah	—	730
Wyoming	--	210
Total[3]	1,230	4,440

[1] Phosphate rock reserves at a cost less than $40 per ton f.o.b. mine. Costs include capital, operating expenses, taxes, royalties (if applicable), miscellaneous costs, and a 15% rate of return on investments. Costs and resources are as of Jan. 1990, f.o.b. mine.
[2] Reserve base at a cost less than $100 per ton f.o.b. mine. Costs are as defined in footnote 1.
[3] Data may not add to totals shown because of independent rounding.

TABLE 29

WORLD PHOSPHATE ROCK RESERVE AND RESERVE BASE

(Million metric tons)

	Number of deposits	Reserves[1]	Reserve base[2]
North America:			
Canada	1	50	50
Mexico	2	10	110
United States	94	1,230	4,440
Total	97	1,290	4,600
South America:			
Brazil	11	330	370
Colombia	1	—	100
Peru	1	310	310
Venezuela	1	—	10
Total	14	640	790
Europe:			
Finland	1	—	70
Turkey	1	30	30
U.S.S.R.	11	1,330	1,330
Total	13	1,360	1,430
Africa:			
Algeria	1	240	240
Egypt	5	—	760
Morocco	10	4,950	20,490
Western Sahara	1	950	950
Senegal	2	—	160
South Africa, Republic of	1	2,530	2,530
Togo	12	—	60
Tunisia	11	—	270
Total	43	8,670	25,460
Asia:			
China	6	210	210
Christmas Island	1	10	10
Israel	4	—	180
Jordan	3	90	480
Syria	2	190	190
Other	6	30	330
Total	22	530	1,400
Oceania:			
Australia	5	90	590
Nauru	1	5	5
Total	6	95	595
World total	195	12,585	34,275

[1] Phosphate rock reserves at a cost less than $40 per ton f.o.b. mine. Costs include capital, operating taxes, royalties (if applicable), miscellaneous costs, and a 15% rate of return on investment. Costs and resources are as of Jan. 1990, f.o.b. mine.
[2] Reserve base at a cost less than $100 per ton. Costs are as defined in footnote 1.

TABLE 30

PHOSPHATE ROCK, BASIC SLAG, AND GUANO: WORLD PRODUCTION, BY COUNTRY[1]

(Thousand metric tons)

Commodity and country[2]	Gross weight					P_2O_5 content				
	1986	1987	1988	1989	1990[e]	1986	1987	1988	1989	1990[e]
Phosphate rock:										
Algeria	1,203	1,073	1,332	1,223	[3]1,102	[e]380	[e]336	[e]404	[e]371	325
Australia	34	11	13	8	14	7	2	2	1	3
Brazil	4,509	4,777	4,672	[r]3,655	[3]2,968	1,620	1,694	[r]1,653	[r]1,293	[3]1,051
Chile	7	10	9	[r]14	12	1	[e]1	[e]1	[e]1	1
China[e]	6,700	9,000	[r]16,600	[r]17,000	17,300	1,810	2,700	[r]4,500	[r]4,600	4,700
Christmas Island (Indian Ocean)	880	842	—	—	—	310	[e]295	—	—	—
Colombia	27	34	35	[r]31	[3]37	7	8	9	8	8
Egypt	1,271	1,167	[e]1,146	[r]1,347	1,300	[e]315	[e]312	[e]293	[r,e]337	325
Finland	527	[e]553	584	[r]580	[3]546	195	[e]195	215	[r]211	201
India	667	679	[r]739	[r]704	659	222	226	[r]246	[r]235	220
Indonesia	1	3	1	11	2	([4])	1	([4])	4	1
Iraq[e]	1,000	1,500	1,273	1,300	1,100	218	330	382	385	325
Israel	3,673	3,798	3,479	3,922	[3]3,516	1,110	[e]1,214	[e]1,092	[e]1,231	1,104
Jordan	6,249	6,800	6,611	[r]6,900	[3]5,925	[e]2,072	[e]2,260	[r,e]2,182	[r,e]2,277	[3]1,945
Korea, North[e]	500	500	500	500	500	160	160	160	160	160
Mali	3	8	10	10	10	[e]1	[e]2	[e]2	[e]2	2
Mexico[5]	747	689	[r]835	[r]655	[3]604	224	207	[r]251	[r]197	170
Morocco[6]	21,178	[r]21,300	25,015	[r]18,067	[3]21,396	[e]6,714	[r,e]6,816	[e]8,061	[r,e]5,781	6,906
Nauru	1,494	1,376	1,540	[r]1,181	[3]926	[e]575	[e]530	[e]593	[r,e]455	355
Pakistan[e]	50	32	35	[r]40	30	16	10	[r]11	[r]13	10
Peru	5	61	13	[r,e]21	5	2	20	[e]4	[r,e]7	2
Philippines	2	[e]8	[r]8	[r]4	4	1	[e]2	[e]2	[e]2	1
Senegal[7]	1,850	1,874	2,326	2,273	[3]2,147	[r,e]671	[e]680	[r]831	[r]823	[3]777
South Africa, Republic of	2,920	2,623	2,850	[r]2,963	[3]3,165	[e]1,060	[e]950	[r]1,079	[r]1,111	[3]1,190
Sri Lanka	15	21	23	[r]24	[3]33	5	[e]7	[e]7	[e]8	11
Sweden	192	[e]221	142	[r]71	7	72	[e]82	52	[r]26	3
Syria	1,606	1,986	2,342	[e]2,250	1,670	485	606	715	[e]690	511
Tanzania	[e]10	18	[r]15	[r]18	20	[e]3	[e]5	[r]4	[r]5	6
Thailand	5	5	8	[r]7	[3]10	1	2	[e]2	[r]2	3
Togo	2,314	2,644	3,464	3,355	[3]2,314	840	[e]960	[e]1,257	[e]1,208	840
Tunisia	5,951	[e]6,390	6,103	[r]6,610	[3]6,259	1,712	[e]1,836	1,813	[r,e]1,897	1,815
Turkey	3	19	74	[r]85	[3]87	[e]1	[e]6	23	26	[3]27
U.S.S.R.[e]	33,900	34,100	34,400	34,400	33,500	10,700	10,750	10,850	10,850	10,200
United States	38,710	40,954	45,389	48,866	[3]46,343	11,857	12,491	13,833	14,893	14,124
Venezuela	174	99	—	237	[3]165	45	28	—	57	[3]34
Vietnam[e]	530	300	330	[r]500	274	175	105	115	[r]175	96
Zimbabwe, concentrate	136	155	125	[r]134	[3]156	[e]47	[e]54	44	47	[3]56
Total	[r]141,029	[r]147,617	[r]162,041	[r]158,966	154,106	[r]45,620	[r]47,870	50,688	[r]49,389	47,508

See footnotes at end of table.

TABLE 30—Continued

PHOSPHATE ROCK, BASIC SLAG, AND GUANO: WORLD PRODUCTION, BY COUNTRY[1]

(Thousand metric tons)

Commodity and country[2]	Gross weight					P_2O_5 content				
	1986	1987	1988	1989	1990[e]	1986	1987	1988	1989	1990[e]
Basic (Thomas converter) slag:										
Argentina	(3)	(3)	e(3)	(3)	(3)	e(3)	e(3)	e(3)	e(3)	(3)
Belgium[e]	180	175	170	165	160	32	32	31	30	30
Egypt[e]	8	8	8	8	8	2	2	2	2	2
France	855	r768	r775	r701	700	154	r138	r140	r126	125
Germany, Federal Republic of:										
Western states	374	r e300	r e250	r e250	220	54	e50	e45	e45	40
Luxembourg	620	542	r664	r680	600	112	98	r120	r122	108
Total	2,037	r1,793	r1,867	r1,804	1,688	354	r320	r338	r325	305
Guano:										
Chile	8	6	4	r3	2	1	e1	e(3)	e(3)	(3)
Philippines	3	e1	1	r48	40	1	e(3)	e(3)	r16	13
Seychelles Islands[e]	5	5	5	5	5	2	2	2	2	2
Total	16	12	10	r56	47	4	3	2	r18	15

e Estimated. r Revised.

[1] Table includes data available through May 31, 1991. Data for major phosphate rock producing countries derived in part from the International Fertilizer Industry Association; other figures are from official country sources where available.

[2] In addition to the countries listed, Belgium and Uganda may have produced small quantities of phosphate rock and Namibia may have produced small quantities of guano, but output is not officially reported, and available information is inadequate for formulation of reliable estimates of output levels.

[3] Reported figure.

[4] Less than 1/2 unit.

[5] Includes only output used to manufacture fertilizers.

[6] Production from Western Sahara area included with Morocco.

[7] Does not include aluminum phosphate production, gross weight, in thousand tons: 1986—131; 1987—191; 1988—119; 1989—115 (estimated, revised); and 1990—111 (estimated).

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